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Development of Interactive E-Module Based Android on Salt Hydrolysis Material to Improve High Order Thinking Skills

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Abstract: This study aims to develop a valid and feasible Android-based interactive e-module on the subject of salt hydrolysis to improve High order thinking skills of students. The research method used is Research and Development (R&D) with the ADDIE model. The research instrument is a validation test questionnaire and feasibility test with qualitative and quantitative data analysis techniques. The results of the expert validation test obtained an average value of 81.85% with Good criteria and in the feasibility test obtained an average value of 88.18% with Good criteria. So that the interactive android-based e-module on the material of salt hydrolysis to improve High order thinking skills is feasible and practical to use in learning.

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Introduction

One of the chemical principles taught to students is salt hydrolysis. Understanding the fundamentals of solutions is necessary to comprehend the hydrolysis of salt. Because it contains abstract information such as pictures of the molecules and compounds involved in the salt hydrolysis reaction, salt hydrolysis material is regarded as one of the more challenging types of chemical information to comprehend (Artika & Bayharti, 2021). Furthermore, according to Yotiani et al. (2016), students must be able to compute the pH of a salt solution using the relationship between Ka, Kb, Kh, and Kw, as well as comprehend and explain what makes a salt solution acidic, basic, or neutral. Considering these factors, learning the topic on salt hydrolysis requires higher level thinking abilities from the students.

High order thinking skills are an achievement that students must have in learning so that they are able to become active learners in carrying out activities of analyzing, solving problems, creating and evaluating (Pratama et al., 2017). Students who have High order thinking skills is able to understand and reason on abstract concepts. The development of technology in the 21st century makes it easier to find solutions to the above problems. One of the uses of technology in learning is the use of interactive learning media that can foster students' enthusiasm for learning. Technology has a very important role in supporting the process of learning chemistry in understanding concepts and training students' thinking skills (Pepi et al., 2019). The development of technology allows learning to be done offline or online. This requires teachers to adapt to these conditions and encourages teachers to be creative in using technology, preparing teaching materials and delivering learning materials through technological media (Fitriyana et al., 2020) so that the material can be conveyed to students properly as in the face-to-face learning process.

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The ongoing development of the curriculum demands that learning is not centered on the teacher (teacher centered), but students must also be actively involved because teachers are not the only source of learning. So that students can obtain knowledge in depth (deep learning) (Satriaman et al., 2018). This requires students to be able to learn independently according to their abilities. The design that allows this to be achieved is using learning media in the form of modules that are collaborated with technological developments into an electronic module which is then known as an e-module. This e-module contains learning materials that are displayed in the form of images, audio, animation and video that are interactive so that learning will be more interesting for students (Ricu Sidiq & Najuah, 2020).

Previous research shows that the use of e-modules in the learning process can increase student activity and make the learning process run effectively (Ditama et al., 2015). Other results state that the use of e-modules in learning shows the effectiveness of learning outcomes, student activity and student learning completion by 90% (Gunawan, 2018). In its use, e-modules can be used on several devices such as laptops, tablets and androids. All of these devices have varying levels of learning effectiveness.

Based on the description above, e-module can be one of the solutions offered in optimizing chemistry learning, especially in salt hydrolysis material. The creation of e-module on salt hydrolysis material has been carried out by (Ditama et al., 2015) using a PC (Personal Computer) or laptop. The results of the study indicate that the use of computer-based e-module is feasible to be used as a learning medium with a percentage of results of 92.08%. However, the study did not specifically include High order thinkingskills. Another device that can be used in operating the e-module is an Android device. According to (Kuswanto & Radiansah, 2018), Android is an operating system for Linux-based mobile devices that includes an operating system, middleware and applications. The advantage of Android over personal computers is that it is more practical and portable so it can be used anytime and anywhere. This greatly supports learning both face-to-face and online. Based on the description above, the researcher assesses that one solution to overcome problems in learning salt hydrolysis is with an Android-based e-module Different from previous studies, this e-module will focus on the presentation of salt hydrolysis material that can support students' High order thinking skills on the material. This study aims to develop a valid and feasible android-based interactive e-module on salt hydrolysis material to improve students' High order thinking skills.

Research Method

The research method used is the Research and Development (R&D) method, development research aims to produce valid products and test the effectiveness of the product. The model developed is the ADDIE model which consists of five stages, namely Analysis , Design , Development , Implementation and Evaluation (Sugiyono, 2016). In this study, the researcher only carried out 3 of the 5 stages in the ADDIE development model, namely up to the development stage . This is because the research time is limited and adjusted to the needs of the learning situation. The process carried out at each stage is described as follows:

1) **Analysis**

   At this stage, the researcher conducts two stages of analysis related to the research to be conducted, namely performance analysis, which is an analysis of problems in ongoing learning. Then the needs analysis, which is an analysis of the solutions needed to

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overcome the problem and how the availability of supporting facilities to implement the product/solution so that researchers can determine the media/products to be created.

2) **Design**
At this stage, the researcher begins to determine the design of the e-module media to be created, then determines the software to be used so that later the product can be used with adequate supporting facilities and begins to design the materials and components needed in the e-module media to be created. All of these designs are used as a reference for the creation of this e-module media which is contained in a flowchart and storyboard. Flowchart is a flow chart that contains information about the process or flow of making this e-module media from the preparation to the final result of the media (Ridlo, 2017). While Storyboard is a general design of a media/application that is arranged in sequential layers and is equipped with descriptions and specifications of each image, layer and text (Dhimas, 2013).

3) **Development**
At the development stage, the media creation was started by researchers according to the steps in the design stage. As is common with R&D methods, then validation and feasibility tests were carried out. The validation test was carried out with an assessment from a team of experts in this case material experts, media experts and learning experts consisting of 3 experts in total. The validation test was carried out to determine the validity of the media that had been created. Then a feasibility test was also carried out on 10 students to determine whether the e-module media that had been created was suitable for use in a learning activity.

The types of data used in this study are qualitative and quantitative descriptive obtained through research instruments. Qualitative data is described in narrative form obtained from several research instruments such as flowcharts and storyboards. While quantitative data is described in numerical form obtained from research instruments in the form of validation test questionnaires and feasibility tests processed through statistical calculations. The research instruments used in this study can be described as follows:

1) **Flowchart**
Flowchart is a procedure stage that is presented systematically through a graph or flow chart. This instrument is used as a reference in making an android-based hydrolysis e-module with the aim of being able to improve High order thinking skills. In this study, the flowchart is a reference for researchers in carrying out the stages of making an e-module based on the flow presented. With this flowchart , product making is easy to understand by users or other research in the future (Sokop et al., 2016).

2) **Storyboard**
In this study, the storyboard is used as a description of the e-module design that will be made and arranged sequentially. The storyboard is also a reference in making an android-based salt hydrolysis e-module product to improve High order thinking skills. The image can lead someone so that the resulting perception is the same as the story idea of making the related product (Elfinurfadri et al., 2013).

3) **Validation Test Questionnaire**
This questionnaire was created to determine the feasibility and quality of learning media obtained from validation data by validators before the product was tested. This questionnaire was addressed to media experts, material experts related to salt hydrolysis material and learning experts related to High order thinking skills who will assess the media from various aspects such as material content, videos and images used to the

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letters used in the learning media which are equipped with suggestions for improvement (Sugiyono, 2016).

4) **Eligibility Test Questionnaire**
This questionnaire was created to find out respondents' responses to the products made. Students as respondents will assess the media made after conducting limited trials with assessment aspects such as material, media and usability.

The data obtained in this study were obtained from several respondents through filling out the validation test questionnaire and the feasibility test questionnaire. The validators in the validation test consisted of one lecturer as an expert in the material related to salt hydrolysis, one lecturer as an expert in media, one chemistry teacher as a learning expert and 10 students of class XI MA As-Sa'adah Sukasari Sumedang as respondents in the feasibility test. The determination of these respondents was based on the salt hydrolysis material that would be studied in the even semester. Data collection techniques can be seen in the following table.

Table 1 Data Collection Techniques

No	Data Source	Target	Collection Techniques	Instrument
1.	Researcher	Development of android-based salt hydrolysis e-module	Making storyboard, flowchart and e-module of salt hydrolysis based on android	Storyboard, flowchart, and media creation software
2.	Validator	Validation of android based salt hydrolysis e-module	Validation test of android-based salt hydrolysis e-module product by material experts and media experts	Validation test questionnaire
3.	Student	Easibility of android-based salt hydrolysis e-module product	Feasibility test of e-module hydrolysis of salt based on android	Feasibility test questionnaire

Referring to the type of data used, the researcher uses qualitative and quantitative data analysis. Qualitative data analysis is in the form of descriptive text from the results of validation tests and feasibility tests, while quantitative data analysis is in the form of numbers generated through calculations on the validation test questionnaire and feasibility test. In more detail, it can be described as follows:

1) **Qualitative Data Analysis**
The stages of content creation and display of the Android-based salt hydrolysis e-module are analyzed by describing it so that the output obtained is in the form of suggestions and input from the results of validation tests and feasibility tests.

2) **Quantitative Data Analysis**
Quantitative data is generated from a validation test questionnaire and a feasibility test in the form of a Likert scale with a scale range of 1-4 with the form of answers consisting of very bad, bad, good and very good. The resulting data is then processed using the following formula:

$$Result = \frac{Skor\ obtained}{Skor\ maximum} \times 100$$

Based on these results, we get figures that can be expressed in the form of qualitative data by looking at the criteria in the following table.

Table 2. Interpretation Table of Feasibility Test Values

Score	Category
91 – 100	Very Good
71 – 90	Good

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51 – 70	Bad
<51	Very Bad

(Kemendiknas, 2010)

Results and Discussion

1. Display of Interactive E-module Based Android on Salt Hydrolysis Material to Improve Higher Order Thinking Skills

The first stage of development carried out is data analysis, namely analyzing data in the form of work analysis to identify problems in learning and needs analysis to determine the solutions needed for these problems. Then continued by collecting data that will be used as material for making e-modules in the form of analysis and concept maps, indicators and learning objectives, and learning materials on salt hydrolysis. The next stage is the media design stage. At this stage, the software to be used is determined. Then a flowchart and storyboard are made based on the results of the analysis stage. A flowchart is a flow chart that contains information about the process or flow of making this e-module media from preparation to the final results of the media (Ridlo, 2017). The flowchart made for an interactive android-based e-module on salt hydrolysis material can be seen in the following image.

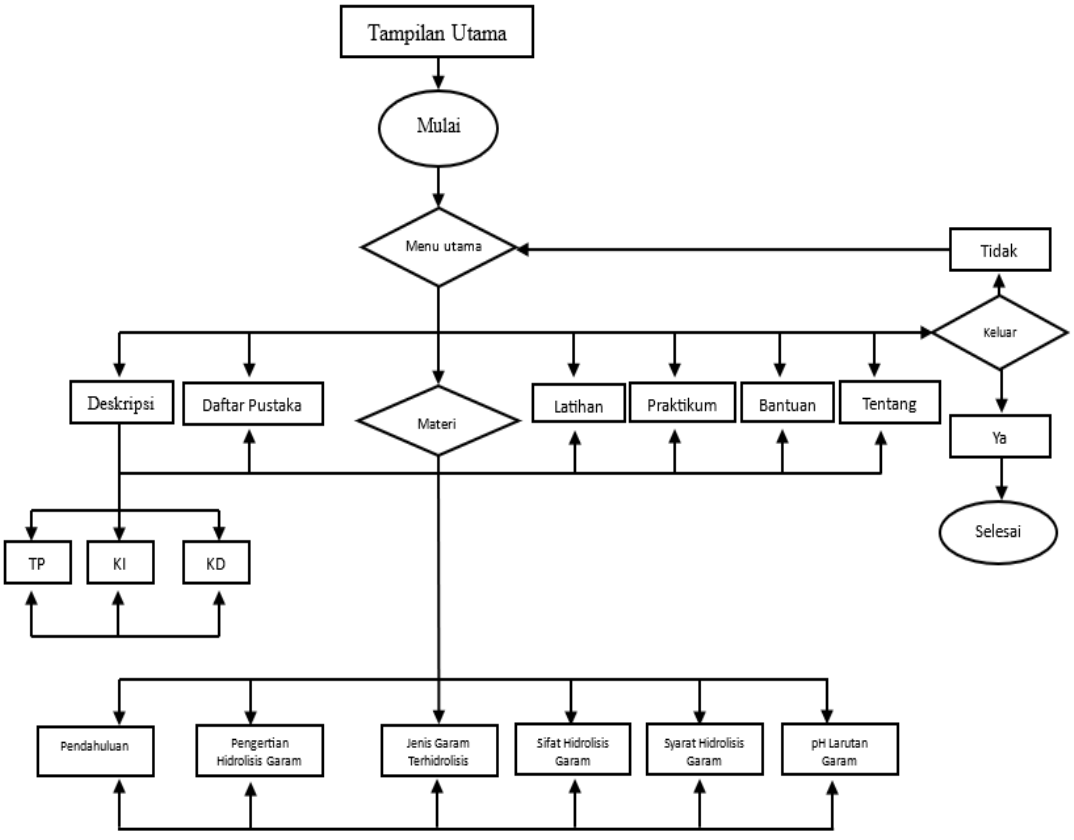

Figure 1. Flowchart of Salt Hydrolysis E-Module

The concept of making an e-module contained in the flowchart is then changed into a storyboard to facilitate the process of making an e-module. Initial view of the e-module can be seen below.

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Figure 2. Beginning Appearance of E-module

The beginning appearance contains several components including the e-module title and the start button. The name of this media directly says "Salt Hydrolysis" which indicates that this e-module is a learning media containing salt hydrolysis material. Then the start button will direct the user to start learning using this salt hydrolysis e-module . If the user selects the start button, the user will enter the main menu display which can be seen in the following image.

Figure 3. Main Menu Appearance

The menus presented on the main menu page include the description menu, bibliography menu, material menu, exercise menu, practicum menu, help menu and about menu. The description menu contains several menus including core competencies (KI), basic competencies (KD) and learning objectives. The bibliography menu contains a list of references used in making this salt hydrolysis e-module. The material menu contains aspects that will be studied in this salt hydrolysis e-module. The exercise menu contains questions as exercises for students in understanding the salt hydrolysis material through this e-module . The practicum menu contains worksheets and practicum simulation videos for students. The help menu contains instructions for use and the function of features on the salt hydrolysis e-module . Meanwhile, the about menu contains profiles or personal data of parties who contributed to the preparation of this media. Several e-module displays that have been developed can be seen in the following image.

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Figure 4. Interactive E-Module Appearance of Salt Hydrolysis

2. Results of the Validation Test of Interactive e-module Base Android on Salt Hydrolysis Material toImprove High Order Thinking Skills

This validation test was conducted on three aspects, namely the material aspect that assesses the presentation of the material, the content of the material, the use of language in presenting the material aspect, the media aspect with the assessment criteria on the preparation of components and software used and the high- level thinking aspect with the assessment criteria of the content, construct and language used. The results of the validation test on the creation of an interactive e-module based on android on the material of salt hydrolysis are presented below.

Table 3. Results of Validation Tests on the Creation Interactive E-Module of Based Android on Salt Hydrolysis Material

No	Aspect	presentation	Criteria
1.	Media	83,33%	Good
2.	Material	82,22%	Good
3.	High Order Thingking Skill	80%	Good
Average		81,85%	Good

Based on Table 3, the validity results of the interactive e-module developed obtained a percentage of material feasibility of 83.33% with good criteria, media 82.22% with good criteria, and High order thinkingskills 80% with good criteria. The average value of all aspects obtained a value of 81.85% with good criteria so that it can be concluded that the android-based interactive e-module on the salt hydrolysis material is valid with several suggestions and improvements. These suggestions and improvements can be seen in the following table.

Table 4. Suggestions and Improvements

No	Before Repair	After Repair
1		
Improvement note: the image is too simple, it would be better if other accessories and ornaments were added to make it more attractive.		

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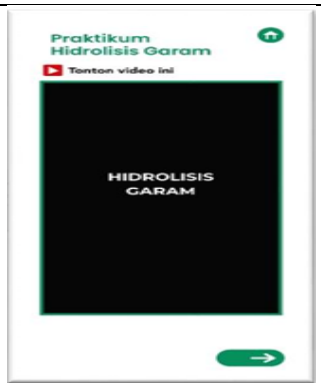
No	Before Repair	After Repair
2		
Improvement Note: In terms of design, it looks good, clear and attractive, but it would be better if the introduction menu was included together with the sub-materials in the material menu, and a bibliography menu was added so that the e-module created is scientific and the truth of the material can be tested.		
3		
Improvement Note: because it is only a practice question, it would be better if a back button is included so that students can go back to studying the material in the question and do not have to solve it first. Each question must be accompanied by a discussion.		
4		
Improvement information: the appearance and content of the worksheet are good, but it would be better if a demonstration video of the practicum was presented so that students can do the practicum well and add an interactive aspect to this e-module.		

3. Results of the Feasibility of Interactive *E-module Based Android* on Salt HydrolysisMaterial to Improve High-Order Thinking Skills

The feasibility test conducted in this study took place at Madrasah Aliyah As-Sa'adah Sukasari Sumedang with a total of 10 respondents, grade XI students. Several aspects assessed include aspects of student interest in e-modules. Android-based salt hydrolysis, the material presented, the use of language and aspects of how to use this Android-based salt

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hydrolysis e-module. The results of the e-module feasibility test Android-based salt hydrolysis can be seen in the following table.

Table 5. Feasibility Test Results

No	Aspect	Presentation	Criteria
1	Student interest	87,50%	Good
2	Material	88,12%	Good
3	Language	88,33%	Good
4	Technical quality	88,75%	Good
Average		88,18%	Good

Based on the data in table 5, the aspect of student interest is at a value of 87.50% which indicates good, for the aspect of material presentation it is 88.12% which indicates good, for the aspect of language use it is 88.33% which indicates good, and the aspect of how to use it in technical terms is 88.75% which indicates good. So that the average value obtained from all data is 88.18% which indicates good results.

Discussion

The media developed by researchers is an interactive e-module based android on salt hydrolysis material to improve high order thinking skills. This e-module is two-way interactive because there are animations, images and videos in it. The display of the interactive e-module based android on the salt hydrolysis material is in the form of a home page that displays animation and there is a start button to start learning and enter the main menu page. This main menu consists of several sub-menus including description menu, bibliography, materials, exercises, help practicum and about menu. The description menu contains information about core competencies, basic competencies and learning objectives that students must have either before or after learning using an interactive android-based e-module on this salt hydrolysis material. The bibliography menu contains information about the references used by researchers to create this e-module.

The material presented and discussed in the android-based interactive e-module on this salt hydrolysis material is salt hydrolysis with several sub-titles, including introductory material, understanding salt hydrolysis, types of salt hydrolysis, properties of hydrolyzed salts and determination of pH of salt solutions. Then the practice menu contains practice questions that can be used by students to measure the extent of their understanding of the salt hydrolysis material (Pratama, et al., 2017).

The questions given in the practice menu can support students to have High order thinking skills. This is because the questions presented meet the cognitive levels of applying (C3), analyzing (C4), evaluating (C5) to creating (C6) which refer to the theory of bloom's taxonomy (Solihudin, 2018). A demonstration video of the practicum is presented in this e-module in the practicum menu with the hope that it can help students carry out the practicum of determining the acid-base properties of a salt solution (Rahmawati, 2018). In practice in the classroom, the worksheets and videos on the interactive module base android on salt hydrolysis material is a reference for students in conducting practicums. After the practicum is completed, students are required to make a report on the results of the practicum and present it in front of the class. This supports students to have high order thinking skills based on the cognitive levels of evaluating (C5) and creating (C6). So it is expected Students can analyze, explore information, communicate, ask questions and create (Mubarokah, 2019).

The next stage after the interactive e-module based android on the salt hydrolysis material was successfully created is the product validation test. The validation test includes several aspects including material, media and learning aspects. This validation test involves

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experts as validators consisting of material experts assessing the salt hydrolysis content presented, media experts assessing the media developed related to the software and learning experts assessing aspects of high order thinking skills.

The results of the validation test on the material aspect obtained a percentage of 83.33% with good criteria. The criteria assessed in this aspect include the appropriateness of the content, the appropriateness of the presentation, the use of language and the completeness of the presentation. The criterion that obtained the highest score was the appropriateness of the content with a score of 86.10% which showed that the material presented was complete and accurate between the concept and other supporting elements such as images, animations and videos in the android-based interactive e-module on this salt hydrolysis material. While the criterion that received the lowest score was the completeness of the presentation which received a score of 80.6%.

The results of the validation test on the media aspect obtained a percentage of 82.22% where the criteria assessed in this aspect include software engineering and presentation components. Software engineering includes functionality, usability, efficiency level and portability. Meanwhile, the presentation components include presentation techniques, presentation support, learning presentation and completeness of presentation in the introduction, content and closing sections. The criteria that obtained the highest value in the media aspect were software engineering with a percentage of 85.18% with good criteria indicating that the e-module has good conformity between the content and the features in it. Meanwhile, the presentation component criteria obtained the lowest value of 77.78%.

The results of the validation test on the high order thinking skills aspect obtained a score of 80% with good criteria and was the lowest score compared to other aspects. In this aspect, the criteria assessed include content, construction and use of language, especially in the questions given in the practice menu in the android-based interactive e-module on the salt hydrolysis material. This aspect received the lowest score due to the lack of content presentation that leads to High order thinking skills. Therefore, improvements were made, especially the addition of practice questions given with questions that have a high cognitive level according to Bloom's taxonomy, especially from the evaluating (C5) and creating (C6) levels, so that it is expected to improve High order thinking skills (Saraswati & Agustika, 2020).

In the aspect of high order thinking skills, the criteria that obtained the highest score were in the criteria for the accuracy of language use which obtained a score of 83.33% because the languageused could be easily understood clearly by users. Meanwhile, the criteria that obtained the lowest score were in terms of content with a score of 75%. This is because there are still a lack of aspects that support High order thinkingskills. Therefore, improvements were made as explained above to support High order thinkingskills (Rahmawati, 2018).

In the final stage, the researcher conducted a feasibility test on limited students as respondents. The criteria that will be assessed by the respondents include students' interest in the android-based interactive e-module on the salt hydrolysis material, the material presented, the use of language and technical quality which includes how to use this e-module. Based on Table 5, the criterion that received the highest score was technical quality or how to use it with a score of 88.75% which indicates good criteria. This is because the operating method of the android-based interactive e-module on the salt hydrolysis material is very clear and easy to understand. While the criterion with the lowest score is student interest with a score of 87.50%, this is because students feel that they have not been able to master the salt hydrolysis

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material as a whole, but in the criteria for the material presented they think it is clear and easy to understand so that the android-based interactive e-module on the salt hydrolysis material is feasible to be implemented because it supports students' High order thinkingskills (Mubarokah, 2019).

Conclusion

The conclusion obtained from the results of this study is that the interactive Android-based e-module on the material of salt hydrolysis to improve High order thinking skills is valid and feasible to be used in learning with an average value of the validation test results of 81.85% and the feasibility test results of 81.18%.

Recommendation

The recommendations submitted based on the results of this study are as follows;

1) For students, this Android-based interactive e-module on salt hydrolysis material can be used as a learning medium or tool to study and understand salt hydrolysis material
2) For further researchers, it is hoped that there will be development and improvements in terms of content, language use and other software engineering so that this e-module can really be used in learning.
3) For educators, this Android-based interactive e-module on salt hydrolysis material can be used as a learning medium for salt hydrolysis material so that students' interest in studying chemistry increases.

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